Case study 9

Water management to identify periods of stress to the supply-demand balance

Focus: The use of seasonal forecasts for water management to identify periods of stress to the supply-demand balance

Industrial and research partners

The SECLI-FIRM project aims to demonstrate how improving and using long-term seasonal climate forecasts can add practical and economic value to decision-making processes and outcomes, in the energy and water sectors. To maximise success, each of the nine SECLI-FIRM case studies is co-designed by industrial and research partners. For this case study, the industrial partner is Thames Water and the research partner is the UK Met Office.

Boosting decision making

- The water industry case studies will explore the application of seasonal forecasting to identify periods of stress to the UK supply-demand balance. These seasonal signatures may highlight chronic or acute periods of stress many weeks out, which will affect the operational management of the water system and the experience of the consumer through supply restrictions.

The seasonal forecasting context

- This case study will explore the ability to identify periods of chronic stress (prolonged excessively high demand driven by either leakage or consumption). Climatologically, these will include conditions indicative of dry and hot summers, or drought conditions, or peaks in demand due to long periods of below average winter temperatures. If such conditions were predictable at seasonal timescale, it would help to flag high demand and support preparedness in terms of capacity and demand management.
- This case study will also explore the ability to identify acute stress (highly variable demand) including heat waves or extremely cold and/or freeze-thaw conditions. If such conditions were predictable at medium/seasonal timescale, it would help flag high variability in demand and support preparedness in terms of resilience.

Sectoral challenges and opportunities

- The United Kingdom (UK) water supply market operates within the private sector comprising of a number of autonomous water companies. The sector is overseen by the Office of Water Regulation (OFWAT), which focuses on consumer regulation. The Environment Agency focuses on environmental regulation. The water businesses constantly balance supply of raw water with demand. Both supply and demand have a significant dependency on the weather.
- By timely identification of potential risks, we will explore whether it is possible to secure customer supply and optimise operational costs.

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Essential climate variables

- Temperatures (max / min / average)
- Rainfall
- Sunshine hours
- Soil moisture deficit

Water management

Climate change, along with population growth and environmental concerns, could present a real challenge to the water industry in the future by reducing the amount of water available for abstraction from the environment. Improved seasonal weather forecasting may allow us to mitigate the impact of extreme weather events that climate change could bring, on both our customers and the environment.

Business process

The project will use existing models that incorporate the dependency of demand on weather out to 12 days ahead. Several water companies in the UK use these models and the case studies will evaluate the use of seasonal forecast information for catchments with distinct climatology. The water demand models developed using observed weather data may not require additional calibration to utilise seasonal forecast data.

The water industry case studies will explore the application of seasonal forecasting to identify periods of stress to the supply-demand balance covering the winter and summer months. All case studies will consider the alternative decisions that could be made if the seasonal forecast information was available and will be evaluated in respect of the outcomes.

Chronic loading case studies

One case study will explore the value of seasonal forecasts leading up to a period of water use restrictions. For example, the UK experienced a run of dry months and then a very wet April in 2012. Water restrictions were imposed in early spring, prior to the arrival of wet conditions. This case study will explore the current skill of seasonal forecasts to predict rainfall and temperature over the UK and determine the benefits of such information for Thames Water in supporting go/no-go decisions on demand restrictions.

The case study will further examine the 2012 outcomes on the Thames Water catchments, against high impact events for a different climatology in the UK in United Utilities' catchments in the North West of England. During the period of 2010, United Utilities experienced a similar period of drought followed by rapid rainfall. In both examples, the use of dynamic data overlaying the climatology may have enhanced the situational awareness.

Industry context

Management of supply and demand to optimise operational efficiency

Business process

Using existing industry demand models to assess the value of seasonal forecasts for several high impact events

Climate events

Summer 2012 and 2017

Winter 2010/2011 and 2017/2018

Acute loading case studies

During July 2017 extreme heat was followed rapidly by wet weather which meant demand moved from abnormally high to abnormally low in the space of a few weeks. When events driving this kind of volatility last for more than a few days, increases in demand cannot be absorbed by judicious use of reservoir storage.

At best, this leads to increased operational expenditure, and stress on the biological production processes. At worst, the increased customer demand may lead to low pressures or even supply interruptions. Any insight into the likelihood and severity of such conditions could allow production capacity to be adjusted to improve resilience and operational efficiency of the system.

During the winter of 2017/18, significant increases in water demand were experienced because of unusual prolonged freezing and rapid thawing weather conditions. This resulted in widespread pipe bursts above and below ground on both the customer and the utility pipework. Consequentially there was a significant rise in demand, which placed great stress on water production and distribution assets, and reservoirs. Extreme actions were taken to rapidly increase water production capacity (e.g. the cancellation and postponement of maintenance activities) to meet the increased demand.

Robust winter planning is essential to minimising the risk to supply during these extreme weather events and short-term forecasts do not provide sufficient time to react to impending severe weather conditions.

Progress update

Research suggests at longer lead-times broad-scale circulation types are more predictable than the actual weather itself. As such case study 9 has been exploring the relationship between water demand and larger circulation patterns. It is thought that this methodology may offer more reliable sub-/seasonal signals than that of attempting to directly forecast the weather drivers of the current water demand model.

Case study 9 has been exploring how different classifications of broad scale circulation patterns capture the impact on peak water demand:

1. North Atlantic Oscillation
2. Weather regimes

Figure 1 shows the relationship between the modelled peak daily leakage in high risk months November – March compared to the monthly average NAO index. The graphs show that there is a much higher risk of experiencing critical peak demand values if there is negative NAO.

Sector impacts

Increase operational efficiency

Reduce water restrictions or loss of supply

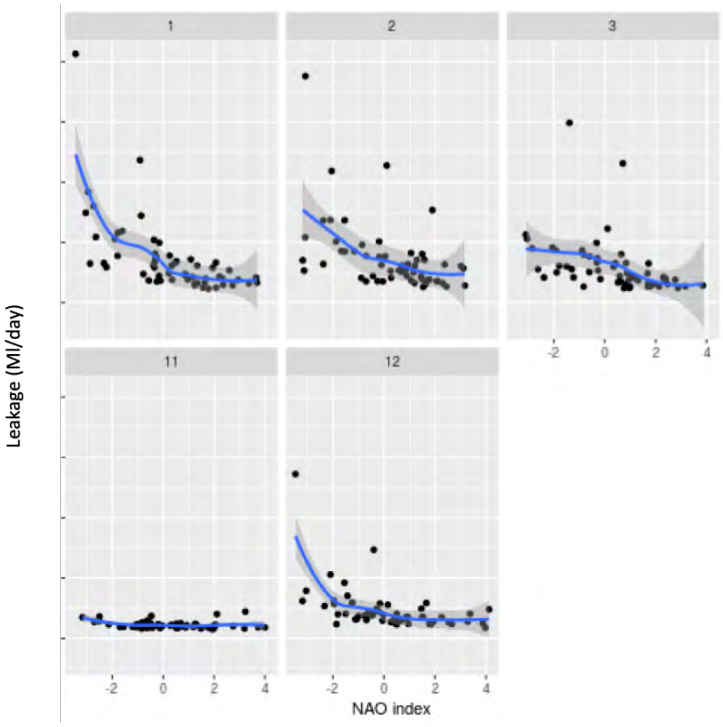

Figure 1: Relationship between modelled monthly maximum leakage for a UK water company and the NAO index for different 'high risk' months of the year.

Next steps

Next steps will involve developing a model relating demand to the NAO and weather patterns and exploring the skill in predicting peak demand periods over the case study period with different lead times. Ongoing activities are focusing on testing which method of tailoring is best for this case study considering both long-term statistics and specific (discrete) events outlined in the case study. Comparisons will be made from a base line calculated using climatology. Quantification of the value-add of the climate forecasts for the management of risk in the water sector will be carried out once the seasonal demand forecast has been optimised and skill assessed against climatology.

The Added Value of Seasonal Climate Forecasting for Integrated Risk Management (SECLI-FIRM)

For more information visit:

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Find out more

For more about this and other SECLI-FIRM case studies, visit www.secli-firm.eu

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